The Feasibility of Three-Dimensional Guglielmi Detachable Coil for Embolisation of Wide Neck Cerebral Aneurysms

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Key words: intracranial aneurysm, Guglielmi detachable coil, 3D GDC, embolisation

Summary

The three-dimensional Guglielmi detachable coil is a modification of the conventional Guglielmi coil. It has a unique complex structure, with alternating small and large loops at 90 degrees angle to each other during deployment. The enhanced coil complexity optimizes coil purchase on the aneurysm wall, promoting coil stability within the aneurysm sac. It may be the solution of the single catheter technique in the embolisation of wide neck aneurysms. We report our early experience in the embolisation of wide neck aneurysms using these complex coils.

Introduction

Endovascular treatment of intracranial wide neck aneurysms is always a challenge for neuroendovascular therapists. Conventional Guglielmi detachable coils (GDCs, Target Therapeutics, Fremont, CA) are sub-optimal for embolisation of wide neck aneurysms or aneurysms with an unfavorable dome to neck ratio.

Various techniques such as balloon remodelling [1], the double microcatheter technique [2] and endovascular stent [3] have been described for endovascular treatment of wide neck aneurysms. Due to the increasing inherent complexity, these methods are not risk-free. Only highly skilled and well-experienced endovascular therapists can perform such treatments. With the newly developed three-dimensional Guglielmi detachable coil (3D GDC, Target Therapeutics, Fremont, CA), embolisation of wide neck aneurysms may be possible without resorting to the use of double microcatheters or remodelling techniques.

At present, it is still too early to predict the outcome of 3D GDC in the treatment of wide neck aneurysms. We report our initial experience in embolisation of unfavorable dome to neck ratio aneurysms using this new product.

Methods

Five cerebral aneurysms in five patients were treated with 3D GDC between March and October 1999. There were three posterior communicating artery aneurysms, one ophthalmic aneurysm and one basilar artery aneurysm. The size of the aneurysms ranged from 6 mm to 16 mm. The necks of all four aneurysms was greater than 4 mm (range 4.8 to 9.5 mm). The mean diameter of the aneurysm neck was 7.26 mm. The average dome to neck ratio was 1.42,

Table 1 **The initial occlusion rate and complication of five aneurysms treated with 3D GDC**

ANEURYSM AND SIZE	RESULT (Initial occlusion)	COMPLICATION
Posterior communicating artery 6 mm	Fail	Loops herniation
Posterior communicating artery 7 mm	subtotal	Nil
Ophthalmic artery 13 mm	Complete occlusion	Thrombo-embolic phenomenon
Basilar artery 12 mm	subtotal	Nil
Posterior communicating artery 16 mm	subtotal	Nil

ranging from 1 to 1.6. The 3D GDC, with the configuration of a series of omega loops, creates a complex, three-dimensional coil shape (figure 1). One appropriate sized 3D GDC was used as the first coil in embolisation of these cerebral aneurysms in our series. Conventional GDCs (2D GDC and Soft GDC) were subsequently deployed to fill the sac of the aneurysms. All procedures were carried out under sedation and full heparinization. Heparin infusion was continued for twenty-four hours after embolisation.

Results

Successful placement of 3D GDC was achieved in four aneurysms (table 1). Although there was 80% success rate, total occlusion could only be achieved in one aneurysm. Subtotal occlusion was achieved in three aneurysms. Recanalisation of the neck of one posterior communicating artery aneurysm was noted after one month and this was embolized with GDC.

There was no procedure-related mortality in our series. One patient died in the intensive care unit from the sequelae of massive subarachnoid haemorrhage.

The 3D GDC formed a stable basket within the aneurysmal sac (figure 2). This enabled further packing of the residual lumen with conventional soft coils. Coil loop herniation into the parent artery is still a problem as noted in one posterior communicating artery aneurysm (figure 3) with a neck size almost equivalent to the size of the dome. The dome to neck ratio of this aneurysm was 1. Persistent coil loop herniation was a problem again even with the use of 3D coils of different size. A thrombo-embolic complication without any neurological deficit was noted in one patient. This complication was a major concern. The tumbling movement of the 3D coil during deployment was unpredictable and might dislodge a clot within the aneurysmal sac. It was not possible to predict the final position of any of the coil loops until the entire coil was deposited just before electrolytic detachment. The 3D GDC was noted to be stiffer than the conventional one.

Discussion

The outcome or success of endovascular embolisation of cerebral aneurysms depends on the size of the neck of aneurysms. The occlusion rate of narrow neck aneurysms (< 4 mm) treated with GDC is relatively good[4,5]. There is higher incidence of achieving complete aneurysm thrombosis of narrow neck then wide neck aneurysms treated endovascularly. Eighty-five percent of aneurysms with neck size smaller than 4 mm showed complete aneurysm thrombosis.

However, there were significantly different results in the wide-necked group. Only 15% of aneurysms with a neck > 4mm showed complete occlusion as reported by Zubillaga et Al[4]. In another study by Debrun et Al[6], the occlusion rates for aneurysms with a dome-to-neck ratio of > 2 were 72%, whereas the occlusion rate was only 53% if the dome-to-neck ratio was less than two. Thus, endovascular embolisation of aneurysms with neck size > 4 mm or unfavorable dome-to-neck ratio is a persistent challenge to endovascular therapists. Numerous adjunct techniques have been reported. Among the most widely used methods is the balloon remodelling technique reported by

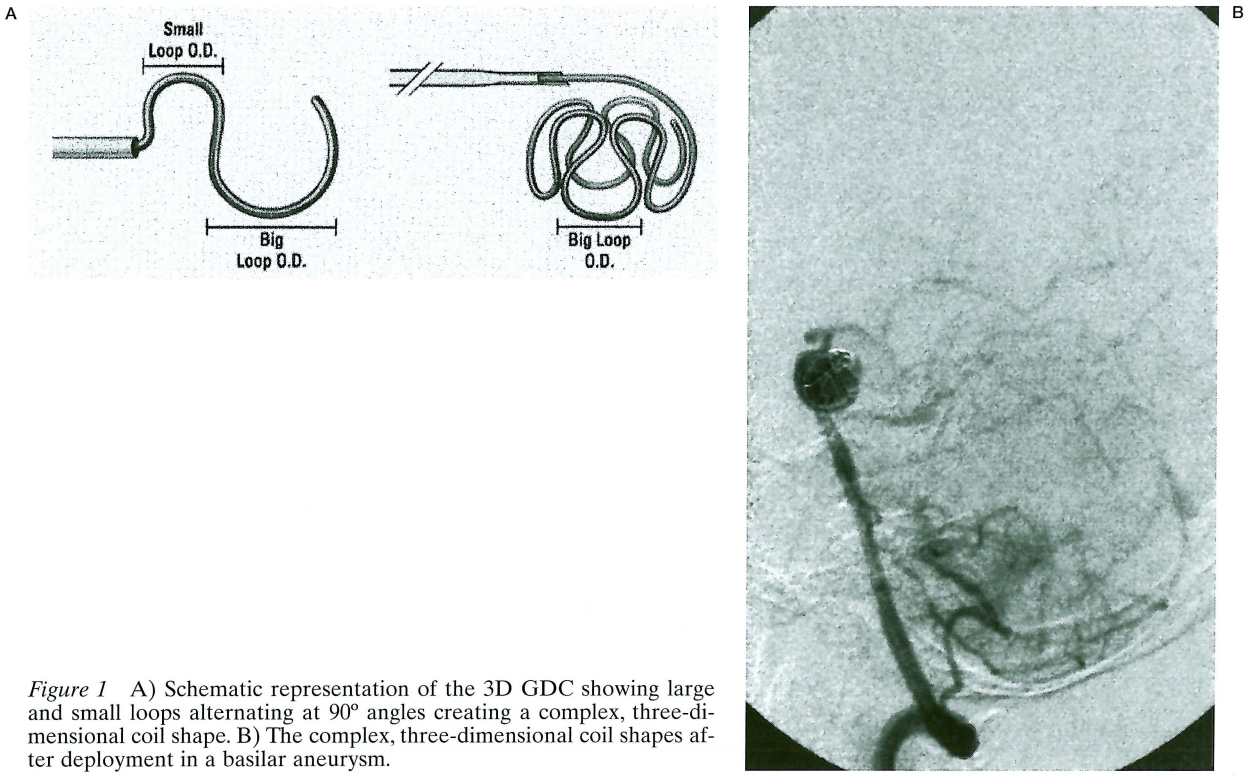

Figure 1 A) Schematic representation of the 3D GDC showing large and small loops alternating at 90° angles creating a complex, three-dimensional coil shape. B) The complex, three-dimensional coil shapes after deployment in a basilar aneurysm.

Moret[1]. In the 56 aneurysms treated by the remodelling technique, he reported 61% total occlusion of aneurysms with neck size > 4 mm. For the aneurysms with neck size of < 4 mm, 92% total occlusion of aneurysms was achieved.

This result is better than that without using the remodelling technique. This is a demanding procedure, requiring extra experience and skill. There may be an increased risk of vessel rupture and thrombo-embolism. The double microcatheter system has also been used that involves deployment of two coils simultaneously[2]. Likewise, there is also an inherent risk of thrombo-embolism with increased complexity of the procedure.

Three-dimensional GDC consists of a series of alternating large and small loops that form 900 angles to each other. These complex omega-shaped loops will form a complex cage during deployment of coils. It optimized coil purchase on the aneurysm wall, facilitating successful coil placement. The cage fills the aneurysmal sac and forms a stable basket, which bridges the neck of the aneurysm. Further deployment of conventional coils inside the stable basket is facilitated. We observed that herniation of coils could still occur when the dome-to-neck ratio is approaching one. The maximum dome to neck ratio where 3D GDC can be safely deployed without herniation of loops of coil into the parent artery has yet to be determined.

The position of the coil is unpredictable and uncontrollable. The 3D coil constantly rotates during deployment with a tumbling motion. The final position of the coil cannot be predicted until the entire coil has been deployed and just before electrolytic detachment. This tumbling motion is a concern. There is a potential risk of dislodging a thrombus within the aneurysm sac.

Furthermore, increased friction between the coil and the wall of the aneurysm during the tumbling motion can be a threat of rupturing the sac or the neck. Therefore extra care is needed in deployment. To reduce this potentially dangerous tumbling motion a larger coil can be used instead. However, this idea requires further evaluation.

The 3D GDC was also noted to be stiffer than the conventional GDCs. This may be sec-

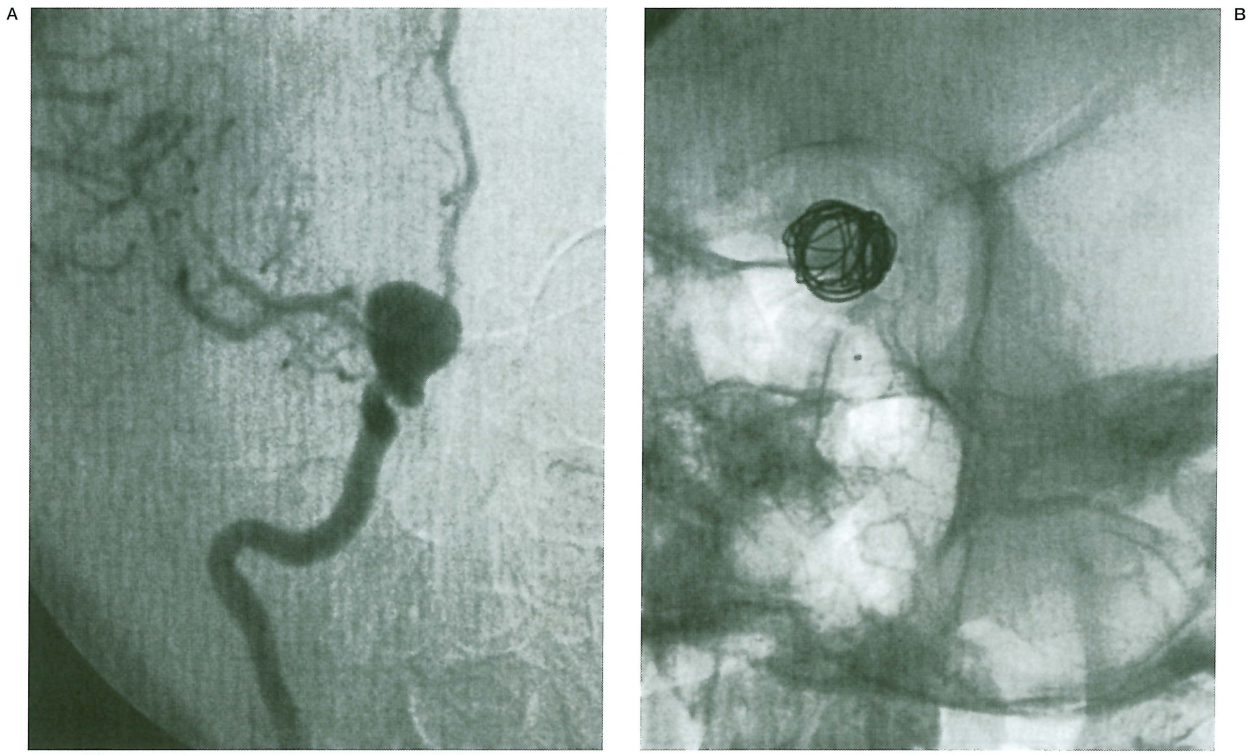

Figure 2 A 45-year-old women presented with right ear tinnitus and headache. A) Carotid angiogram showed a paraopthalmic aneurysm with a dome to neck ratio of 1.5. B) Embolisation of the aneurysm was performed using a 14 mm x 30 cm 3D GDC as the first coil. C) Total occlusion of the sac was achieved with six soft GDCs subsequently.

ondary to the complex nature of the coil. Other possibilities include local mechanical stress being applied to the aneurysm during 3D-coil placement, or friction within the delivery sheath as described by Malek et Al[7].

There are still many uncertainties towards the use of 3D GDC in the treatment of wide neck aneurysms. Coil compaction as seen in the conventional GDCs[8] may be less prominent in this complex coil with an inherent three-dimensional configuration. Long-term follow-up is necessary and only time will tell.

Conclusions

Three-dimensional GDC provides a stable framework in wide neck aneurysms that enables the subsequent deployment of reinforcing conventional GDCs. It could be an alternative to the double catheter and balloon remodelling techniques. Our early and limited experience demonstrated that the 3D GDC might be of value in the embolisation of wide neck aneurysms without adjunctive techniques in some cases. In fact, a higher rate of total occlusion might be achieved with the use of 3D GDC combined with the remodelling technique. However, the long-term efficacy still re-

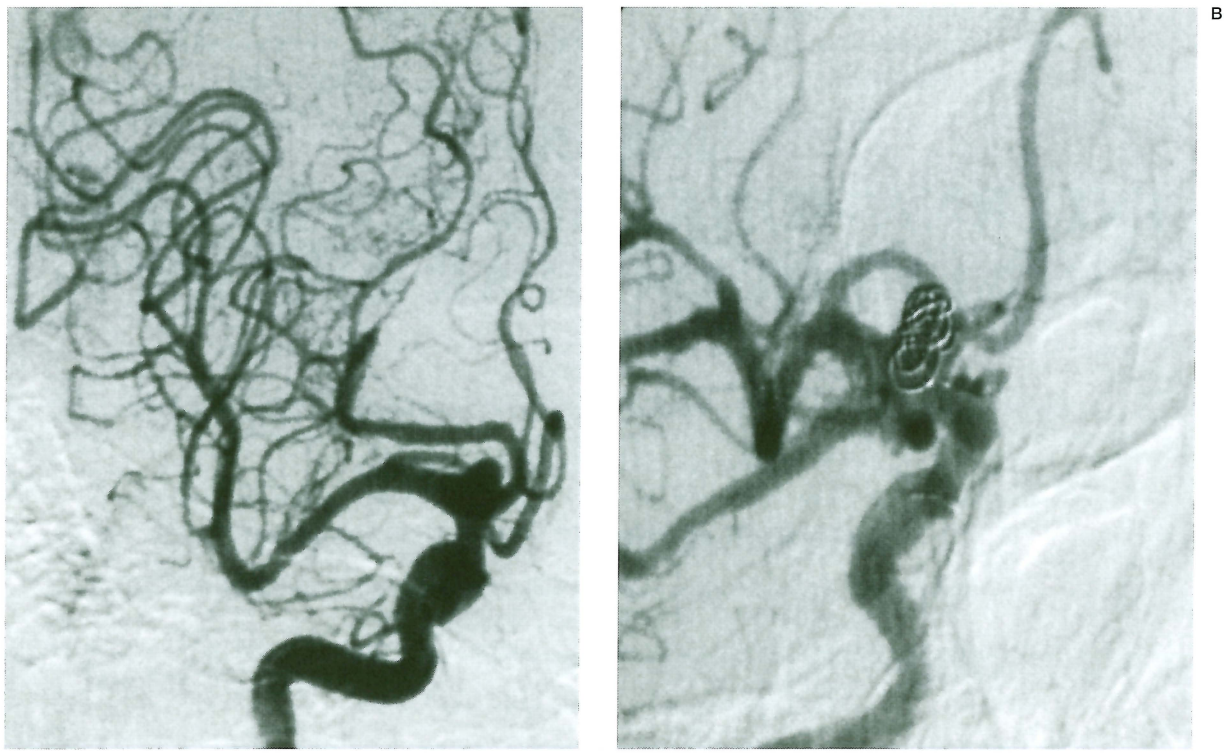

Figure 3 A) A posterior communicating artery aneurysm with a wide neck and dome to neck ratio of 1. B) Persistent coil loop herniation into the parent artery after several attempts at coil deployment. Various sizes 3D GDC had been used without success.

mains unclear. The tumbling motion of the coil possesses a risk of dislodging a thrombus and together with the added stiffness may increase the risk of rupturing the aneurysm during the procedure.

Acknowledgements

The authors would like to thank Boston Scientific for supplying the 3D GDC for this study. We also gratefully acknowledge the cooperation and support of our colleagues in the Department of Radiology and Neurosurgery.

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